TRANSPORTATION AND COMMUNICATION - RIYADH - JEDDAH RAILROAD - REPORT [1 OF 2]

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KINGDOM OF SAUDI ARABIA

REPORT

13-469

on the

RIYADH-JEDDAH SECTION

of the

SAUDI GOVERNMENT RAILROAD

ADVANCE COPY

Prepared for

TECHNICAL COOPERATION ADMINISTRATION, U.S.A.

by

INTERNATIONAL ENGINEERING COMPANY, INC.
74 New Montgomery Street
San Francisco, California, U.S.A.

October 1953

Advance Copy

INTERNATIONAL ENGINEERING COMPANY, INC.
74 New Montgomery Street
San Francisco 5, California

C. P. Dunn
President

October 30, 1953

Office of the Director
Technical Cooperation Administration
Department of State
Washington 25, D. C.

Dear Sir:

I am pleased to transmit herewith a report entitled:

REPORT ON THE RIYADH-JEDDAH SECTION OF THE SAUDI GOVERNMENT RAILROAD.

Accompanying this report is a volume entitled:

SPECIFICATIONS AND DRAWINGS FOR THE RIYADH-JEDDAH SECTION
OF THE SAUDI GOVERNMENT RAILROAD

which should be considered as an appendix to the report.

The report covers field surveys and other work performed in compliance with Agreement No. SCC-14577, dated December 4, 1952, between the United States of America, represented by the Technical Cooperation Administration of the Department of State, and International Engineering Company, Inc.

It has been requested that the report be prepared in both English and Arabic. While we have made every effort to translate the English accurately into Arabic, it is nevertheless necessary to designate the English version as the official report.

We trust that this report fulfills your requirements and that it will assist the Government of Saudi Arabia in starting construction of the proposed railroad at an early date. Should you so wish, it will be a pleasure to discuss with you the subject of this report.

It has been a great pleasure to me personally and to my associates to work on this report. We have enjoyed assisting you in your cooperation with the Government of Saudi Arabia in its enlightened program to bring increased benefits to the people.

Respectfully submitted

INTERNATIONAL ENGINEERING COMPANY, INC.

C. P. Dunn
President

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REPORT

on the

RIYADH-JEDDAH SECTION

# of the

SAUDI GOVERNMENT RAILROAD

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SECTION I

SUMMARY AND CONCLUSIONS

This report, together with the appended volume entitled "Specifications and Drawings", presents the results of careful location surveys, designs of roadway and facilities, and estimates of work and costs for a proposed railroad between the cities of Riyadh and Jeddah in the Kingdom of Saudi Arabia.

The principal engineers assigned to the work were selected for their special qualifications and for their knowledge of the country and people, gained during earlier assignments in Saudi Arabia.

Many of the problems related to the railroad were discussed with officials of the Government of Saudi Arabia, the Saudi Government Railroad, and the Technical Cooperation Administration. In addition, all available data that would bear on the subject were gathered and studied. The location surveys were based on an integrated use of aerial reconnaissance and photography; and ground reconnaissance, checks, and staking. The work was carried through necessary details so that a fully operating railroad would result. A railroad constructed over the route proposed and equipped as described herein will be a first-class railroad from both technical and economic viewpoints, and will be an important factor in the further development of the Kingdom of Saudi Arabia. The benefits the country will derive from a pioneering venture of this type cannot be assessed accurately, but the prospective value has been discussed qualitatively.

The railroad will consist of 854 miles of main line, 124 miles of branch lines, and 32 miles of sidings and yard tracks, making a total of

1,010 miles of track. The route of the main line will connect Riyadh and Jeddah, and will run through Marrat, Anaiza, Al Mussama, Medina, and Yanbu Junction. Branch lines will connect Dhruma, Buraida, Yanbu, and Mecca with the main line.

It has been assumed that all necessary facilities and equipment will be included in the initial construction in order that the railroad will be in full operating condition when it is turned over to the operating management. Such facilities and equipment will include station buildings, offices, warehouses, main shops, living quarters, power plants, water supply, radio communications, rolling stock, and all equipment used in construction.

The cost of the railroad is estimated to be $135,788,000. This total is broken down into the following major items:

1)	Administration and engineering	$ 11,581,000
2)	Roadway subgrade	11,289,000
3)	Roadway ballast	11,600,000
4)	Track	57,661,000
5)	Drainage structures	7,257,000
6)	Buildings	16,263,000
7)	Power plant equipment	4,288,000
8)	Water supply	401,000
9)	Radio communications	1,521,000
10)	Rolling stock, new	13,927,000
	Total	$135,788,000

SECTION II

INTRODUCTION

2.01 SUBJECT OF REPORT

This report is concerned primarily with the location, design, and estimated cost of a proposed railroad between the cities of Riyadh and Jeddah in the Kingdom of Saudi Arabia. This railroad will have certain branches and extensions, including one from Jeddah to Mecca. Other important aspects, such as existing conditions and how they may be affected by the proposed railroad, will also be discussed.

It is intended that a separate volume titled "Specifications and Drawings" shall be considered as an appendix to this report. This appendix defines and describes the railroad and its supporting facilities in technical language and with engineering drawings.

2.02 AUTHORIZATION

On December 4, 1952, International Engineering Company, Inc., of 74 New Montgomery Street, San Francisco, California, U.S.A., was awarded a contract by the Technical Cooperation Administration of the Department of State, United States Government, for making a railroad location survey for the Government of Saudi Arabia. The location was to be between the cities of Riyadh and Jeddah.

Under this contract, International Engineering Company was required to perform the following services:

a. Select the best gauge and locate the most advantageous route from both economical and engineering standpoints, and prepare the necessary maps and profiles showing curves and grades.

b. Furnish specifications, including quantities, qualities and type of track and construction materials and grading required.

c. Make definitions and a cost estimate of drainage structures sufficiently complete to enable construction contractors to prepare final detailed designs.

d. Make definitions and a cost estimate of service structures, including bridges, sufficiently complete to enable construction contractors to prepare final detailed designs.

e. Make an estimate of the quantity, quality, and location of ballast materials, cost of ballasting and track laying, and cost of track material.

f. Within the route from Riyadh to Jeddah, make a final staked-out location survey of fifty (50) miles of railroad, and for this reach make final detailed designs of drainage structures, including bridges, for the immediate starting of construction.

2.03 PURPOSE OF PROPOSED RAILROAD

There is at present a railroad between the port of Dammam on the Persian Gulf and the capital city of Riyadh. Whereas this railroad, in itself, is of great importance, it is also considered as the first link of a trans-Arabian railroad connecting the Persian Gulf and the Red Sea.

Much of the population, industry, and agriculture are concentrated at or near the two coasts, but there are also important population centers in the interior. The proposed railroad will help in unifying and integrating these areas economically. It will promote the further development of these areas as well as the interior through which the railroad will run.

The Dammam to Riyadh railroad was completed by the Saudi Arabian Government in 1950. In the three years since its completion, this railroad has already been a spectacular success, and has contributed greatly to the development of the region it serves. This success demonstrates that it is desirable to extend the present railroad across the interior to the shores of the Red Sea.

2.04 ACKNOWLEDGMENTS

In the performance of this work, excellent cooperation and valuable assistance were received from His Excellency Shaikh Abdullah Suliaman, Minister of Finance, Government of Saudi Arabia. Acknowledgment is also given to the other officials of the Government of Saudi Arabia, members of the staff of the Saudi Government Railroad, officials of the Technical Co-operation Administration, and others who aided in the field survey work and in collecting and contributing essential data.

In March, 1952, the Saudi Government Railroad made a report titled "Preliminary Study, Riyadh-Jeddah Railroad, Saudi Arabia". This report recorded the results of a preliminary survey by motor cars, and was of great value in this current and more detailed survey.

Translations from English to Arabic were done by Mr. Mousa Afifi of the Liaison Office for Technical Assistance, Minister of Finance, Government of Saudi Arabia.

SECTION III

PRESENT SITUATION

3.01 DESCRIPTION OF THE KINGDOM OF SAUDI ARABIA

The Kingdom of Saudi Arabia comprises about four-fifths of the Arabian Peninsula. In area it is 1,100,000 square miles. To the north, the country borders on Jordan, Iraq, and Kuwait; to the east lie the Persian Gulf, Qatar, and Trucial Oman; to the south lie Oman, the Aden Protectorate, and Yemen; and to the west is the Red Sea.

When described very briefly, the topography of Saudi Arabia is characterized as follows: Along the Red Sea there is a narrow coastal plain, Tihama, with a maximum width of about 40 or 50 miles. This plain is bordered by a range of mountains, the Hejaz Mountains, which roughly parallels the coast. These mountains are high and rugged, and have only a few low passes. The western slope is generally steep, while the eastern slope is somewhat more gentle. Beyond these mountains is a vast high plateau, the Nijd, which slopes gently toward the east. Toward the eastern limit of the plateau are large dunes of shifting sand, and another but smaller range of mountains, the Tuwaiq Mountains, running approximately north-south. From these mountains and to the east, the terrain again slopes down toward the Hasa and the Persian Gulf.

The climate is generally classified as hot and arid. Temperatures range from above 120° F down to freezing at the higher elevations. However, the nights are usually comfortable even where the daytime temperatures are high. Precipitation is the highest in the southern part of the Hejaz Mountains, where 10 to 12 inches are recorded annually. The average annual rainfall for the entire country is about 4 inches, and this usually comes in a few showers during the winter.

The population of the Kingdom of Saudi Arabia is about 6,500,000. Some of these people are nomads who move over large areas to graze their animals, but most are settled in farming areas and cities where water is available the year around. Some seacoast communities are partially dependent on fresh water obtained by distilling sea water.

3.02 AGRICULTURE

The date in countless types and varieties has long ranked with grain as the agricultural product of highest importance. To many people it is a staple of the diet and it is exported to all parts of the world. Many other fruits such as peaches, apricots, figs, oranges, bananas, papayas, grapes and melons are also grown successfully. The important grains include sorghums, wheat, rice and barley. Alfalfa is grown in substantial quantities. An excellent quality of coffee is produced, but the quantity is small. A variety of vegetables is raised in limited quantities, including potatoes, onions, squash, beans, and tomatoes.

The greatest source of agricultural wealth is livestock. The camel is the animal most important to the people. It is a beast of burden and transportation, indispensable to the economy of the country, and it will undoubtedly continue to be so even with the advent of the automobile and railroad. The camel provides milk as well as a portion of the meat supply.

Sheep are raised for their meat, milk, and wool, and are second to camels in importance. Goats are raised primarily for their milk and hair, but also for meat. The donkey is used extensively as a work animal. There are a few herds of dairy cattle, encouraged primarily by the market among Americans and Europeans living there. The fleet Arabian horse has long been famous the world over.

Cultivation of fertile land is limited by the restricted amounts of water which can be made available for irrigation. Much water is lost to the sea as surface runoff and underground seepage, and farmers depend mostly on water from springs and wells. The Government is already engaged in an extensive public works program in which the output of old water wells has been increased, new wells have been developed, and experimental farms have been established. The wisdom of this program is already apparent in the substantial increases in agricultural production.

3.03 INDUSTRY

The industry of today is dominated by oil, and this has happened in the course of about two decades. From its first inception to the present large-scale production, the program has been guided wisely by the Government. The Government and the oil company have cooperated so that the oil production has been of vast benefit, both directly and indirectly, to the people.

Some of the world's great oil reserves have been discovered along the coast of the Persian Gulf, and it can probably be said that their development has only been started. The oil and its derivatives are being exported to many parts of the world. The royalties from oil are being plowed back into the national economy through an enlightened public works program which will result in great expansion and improvements in education, public health, water supply, electric power, transportation, and communications, all of which will bring about a high standard of living. Education and public health are cornerstones; increased water supply and electric power will multiply agricultural, livestock, and industrial products; and expanded and improved transportation and communication facilities will make possible the rapid interchange of goods and the movement of people. Many of these benefits are already evident.

Mining is an ancient industry in Saudi Arabia. Recently there has been a reactivation of mining, and concentrates of several metals are being produced. Appreciable quantities of salt are also being produced commercially.

There are several smaller industries, some supply local markets while others export their products. Some of these industries are charcoal making, fishing, boat building, pottery making, and weaving.

3.04 TRANSPORTATION

The most important of the ancient modes of transportation in the Kingdom of Saudi Arabia were the camel and the caravan, and they are still of great importance. Camels do not require improved roads, and the arteries of commerce were therefore little more than trails leading from one watering place to another.

In more recent times, highways were constructed between some of the centers of population, and in some cases these were built primarily to facilitate the travel of pilgrims to Mecca and Medina. That was also the main purpose of the narrow gauge Hejaz Railroad constructed about 1907 between Jordan and Medina. Extension of this railroad to Mecca had been intended but this was never done. The railroad was wrecked during World War I, and it was never repaired.

There are only a few modern motor roads, and these are relatively short. There is no integrated net of highways. Among the good roads must be mentioned the one between Jeddah and Mecca, one of lesser quality between Jeddah and Medina, and the several roads near the Persian Gulf.

The existing Saudi Government Railroad between Dammam and Riyadh will be discussed in some detail in the following sub-section.

It is evident from the above description of existing transportation facilities that a network for rapid transporting of large volumes of agricultural and industrial products is lacking. Each area must be largely self-sufficient, with the produce exchange limited to the local market. A good and rapid transportation system will make it possible for each area to favor production of those goods to which it is especially suited. Not only will such a transportation system promote trade within the country, but it will also encourage trade with foreign nations. It will raise the standard of living of the people, cause the expansion of old activities, and stimulate prosperity with new activities.

3.05 PRESENT SAUDI GOVERNMENT RAILROAD

The present Saudi Government Railroad runs between Dammam, a port on the Persian Gulf, and Riyadh, the capital city of the Kingdom of Saudi Arabia. This railroad was completed and placed in operation in 1950.

The administrative headquarters of the railroad are located at Dammam, a new city of about 10,000 people. The shops for maintenance and repair and the materials yards are also located there. Dammam is the main port on the Persian Gulf, and has a modern pier where ocean-going ships can tie up. The pier is equipped with railroad tracks, so that cargo can be handled directly to and from freight cars, and there is a derrick of 100-ton capacity for heavy lifts on the pierhead. Customs sheds are located conveniently so that incoming cargo can be serviced with a minimum of rehandling. Since completion of the pier in 1950, the amount of cargo handled has exceeded the original estimates, and the Government is now planning to enlarge the port facilities in order to handle the increased traffic.

Eleven miles by rail from Dammam is the city of Dhahran with a population of about 20,000. It is the headquarters for the Arabian -

American Oil Company. The Dhahran Air Base is located five miles from the city, and several international air lines, with connections to all parts of the world, stop here regularly. For the convenience of travelers and others, hotel accommodations are available both in the city and at the air base

Abquaiq is a city of about 10,000 people located 51 miles from Dammam. It is the center of the vast oil field presently developed.

Hufuf has a population estimated at 60,000 and lies 93 miles south of Dammam. The Hufuf area has a large and dependable supply of fresh water, and it is famed throughout the world for its dates. Other crops are also grown in this area, including grains, alfalfa, and vegetables.

The railroad continues in a southerly direction to Ain Haradh, 188 miles from Dammam, and here turns westerly to El Kharj, 298 miles from Dammam. El Kharj is the site of the already famous experimental farm operated by the Government. The Government also has planned other activities for this area, including several large construction projects. The district has a good supply of fresh water, and therefore there are several large villages in the area surrounding El Kharj. The range of produce is similar to that of the Hufuf area.

Fifty-four miles farther west, and 352 miles from Dammam, is Riyadh, the capital city of the Kingdom and the western terminus of the present railroad. The population of Riyadh is estimated to be about 80,000. A modern airport, with scheduled flights by Saudi Arabian Air Lines, is located nearby. There is an appreciable amount of farming and raising of livestock in the surrounding area.

The railroad is built to the modern American standards, with a gauge of 4 feet 8-1/2 inches. All rolling stock is of American standard design, and all main-line and switch engines are diesel powered. There are distinct advantages in such standardization, from the point of view of operation, maintenance, spare parts, and expansion.

3.06 DISTRICTS THAT MAY BE SERVED BY THE NEW RAILROAD

The new railroad, located as proposed, will serve a number of cities and developed agricultural districts. The major ones and their present situation are:

Dhruma is an area about 75 miles from Riyadh, and has a population of approximately 15,000. The people live mostly in several small villages, and their principal activities are farming and raising of livestock.

The Qasim District is located about 250 miles from Riyadh, and is one of the more heavily populated districts of the country. The population is estimated to be 140,000. The major cities of the district are Anaiza and Buraida, but there are also several small towns and villages. The district has a large supply of good water, and it is therefore an important agricultural area. Though not comparable to agriculture, forest products are of some importance here, and athel (tamarisk) trees are grown in considerable numbers. These trees are used for fuel and building construction. It is perhaps of special interest that many of the enterprising people of the area plant athel trees as an agricultural crop. The trees are reputed to require watering only during the first couple of years after transplanting, after which they will survive in the arid climate.

The Hail District, located north of Buraida, is comparable to the Qasim District. It is large in area, is populous, and has an adequate supply of fresh water. Its economy depends primarily on farming and livestock. The district will not be served directly by the railroad, but a highway connecting it with the railroad should be considered. The district will then benefit greatly from the railroad in that the length of truck haul will be substantially reduced.

Medina is a city located on the east side of the Hejaz Mountains at an elevation of 1840 feet, about 584 miles from Riyadh and 270 miles from Jeddah, and has an estimated population of 45,000. In religious importance it is second only to Mecca, and each year it is host to over 75,000 pilgrims. There is some agriculture in the vicinity of Medina, and water is obtained from wells and wadis. Medina is the southern terminus of the now abandoned Hejaz Railroad.

Yanbu is a city with an estimated population of 7,000 located at the Red Sea 205 miles north of Jeddah. A total of about 50,000 people are living within a radius of 50 miles of Yanbu, most of these along wadis where water is available. Yanbu and its tributary area depend on agriculture, trade, and some small industries such as forest products and fishing. Its natural harbor is small and undeveloped, but is deep enough for ocean-going ships. The city was at one time an important gateway to Medina.

Jeddah is the most important city on the Red Sea coast, and has a population estimated at 80,000. It is the gateway to both Mecca and Medina, and during the Haj season over 100,000 pilgrims arrive by ship. It has an excellent harbor with a modern pier, and a derrick on the pierhead can handle heavy lifts up to 50 tons. The pier was designed for truck operation in the handling of cargo between ship and shore. Although this pier was completed in 1950, it is already being worked to capacity. In addition to this modern pier, a mining company has a small pier and lighter service, and there is a municipal wharf for small boats and barges. A paved road leads from Jeddah to Mecca, and another one to Medina is now being constructed. A nearby airport provides air line connections to all parts of the world. Foreign embassies and legations are located at Jeddah, thus making it a diplomatic center. Jeddah is primarily a commercial city, with much trade and shipping, but it also has important interests in fishing and small industries. The surrounding area has some agriculture.

Mecca is located 43 miles inland from Jeddah, and has a population estimated at 80,000. It is the Holy City of the Moslem World, and is host each year to more than 200,000 pilgrims. Trade is an important occupation. The immediate environs support some agriculture, where water is obtained from wells and wadis.

SECTION IV

RAILROAD RECONNAISSANCE, SURVEYS, AND DESIGN

4.01 DATES OF FIELD WORK

The contract for the work was awarded on December 4, 1952, and after a period of organization and mobilization, parties were in the field and started work on January 8, 1953. All field work was completed on June 12, 1953, and the parties returned to analyse the data gathered and to prepare the designs, specifications, and report.

4.02 GENERAL LOCATION OF THE RAILROAD

Officials of the Government and the management of the railroad had given much thought to the location of the new railroad extension prior to the time International Engineering Company entered on the surveys. Several reports were available, including "Preliminary Study, Riyadh-Jeddah Railroad, Saudi Arabia," dated March, 1952. The general route of the new railroad was determined from these earlier studies and discussions. During this stage, full consideration was given to engineering and economic factors as well as to national interests.

The procedure followed in selecting a route and locating the railroad was one of several successive steps in which alternatives were gradually eliminated, and the choice finally narrowed to one concisely defined route. The successive steps and the results from each are described in the following sub-sections.

4.03 AERIAL RECONNAISSANCE

With the benefit of the earlier studies, the first step taken in the field survey was to fly aerial reconnaissance over the area between Riyadh and Jeddah. Several flights were made over the general route previously chosen through Anaiza, Medina, and Yanbu. The routes of greater promise were noted and marked for further study by ground crews. Special attention was given to the difficult areas in the Hejaz Mountains through which the railroad had to pass. This aerial reconnaissance saved much time and expense as it was possible to eliminate much of the ground work which would otherwise have been required to select the best route.

4.04 GROUND RECONNAISSANCE

Following the aerial reconnaissance, ground crews covered the most likely locations selected from the air. Further elimination of alternatives occurred in this stage, and as a result of this ground reconnaissance, the best possible route was selected to the extent that it could be laid out for photographing.

In this stage of the work, a ground party found a good crossing over the Tuwaiq Mountains.

4.05 AERIAL PHOTOGRAPHY AND GROUND CHECKS

The route selected in the ground reconnaissance was flown again, and stereoscopic aerial photographs were taken in a continuous strip. A total of 1,300 lineal miles of strip photography nine miles wide was thus taken. When more difficult problems existed, it was necessary to take area photography, and this totaled 6,580 square miles. Most of this area photography was flown in the mountainous area between Yanbu and Medina and the area east of Medina. The aerial photography resulted in photographs to a scale of 1 to 60,000 or 1 inch = 5,000 feet. These photographs were later made into an aerial mosaic of the same scale. The mosaic in turn, was reduced to a scale of 1 inch = 4 miles so that it could be included in this report.

Laboratory facilities were established in Jeddah so that photographic processing could be done promptly. As soon as possible after exposure, the films were developed and prints made. On the photographs a projection was made of the proposed alignment of the railroad. This projected line was then checked on the ground, and necessary corrections were made. The engineers also designated certain control points clearly distinguishable on the photographs where elevations were to be determined and base lines laid out. The control points were spotted at about 35-mile intervals. Ground survey crews went out to the designated points, measured the required elevations with altimeters, and in the same vicinity laid out the base lines. The elevations and base lines were noted on the photographs. The photographs were then sent to the United States where additional photogrammetry was done. Elevations were obtained along the route of the railroad, and topographic maps were drawn for some selected areas.

The procedure outlined above results in a railroad location which will require only minor adjustments when final staking is done.

4.06 FINAL STAKING

It was a contract requirement that 50 miles of the railroad should be staked so that construction could be started immediately. Field crews therefore made final location surveys, and staked 50 miles of line, starting at Riyadh and running west through Jubaila.

4.07 OTHER FIELD WORK

Drainage areas were checked by field crews, and they determined the requirements for bridges and culverts. Soil conditions were inspected and observations recorded along the entire route in order that construction costs could be estimated more accurately. The locations of existing supplies of water were noted so that the selection of sites for auxillary facilities could be guided thereby. Various possible quarry sites were evaluated, and the locations of the more promising sites were recorded.

4.08 PROPOSED ROUTE OF THE RAILROAD

One of the important factors considered in the selection of the proposed route between Riyadh and Jeddah was that the interests of the Government and the people of the Kingdom of Saudi Arabia would be satisfied best by a railroad following a route which would serve the greatest number of people and the areas with the greatest potentiality for development. It is believed that the proposed route accomplishes this, and that it at the same time is technically sound and economically attractive.

The route is described in the following paragraphs, with division points, midway stations, and line stations listed. Many other communities are also served. It should be noted that the mileposts given have two origins, Riyadh and Jeddah. From Riyadh west, the stationing runs for 50 miles, which is the staked line; and from Jeddah east it runs for 804 miles to join with the other 50 miles.

Mileposts	Description
0 - 50	Riyadh to end of staked line. From Riyadh the line runs north to Jubaila (MP.26). Here it turns west and climbs the Tuwaiq Mountains. The end of the staked line is slightly short of the

summit. In this reach the line follows Wadi Hanifa.

804 - 749 End of staked line to Marrat. From the end of the staked line, the route continues westward over the summit of the Tuwaiq Mountains (MP.801) and down along Wadi Hish to Dhruma Junction (MP.788). Here a 14-mile long branch line connects the railroad with Dhruma. From Dhruma Junction the line runs northwest to Marrat.

749 - 604 Marrat to Anaiza. From Marrat the line runs westerly through Shagra (MP.730), and then crosses the Nefud (sand dunes) to Usaila (MP.692). At Usaila the route turns northwest and runs through Junaitha (MP.662) and Mudhnib (MP.630) up to Anaiza. Anaiza has a junction for a 20-mile branch line running north to Buraida.

604 - 424 Anaiza to Al Mussama. At Anaiza the route turns sharply westward and it follows Wadi Rima to Rass (MP.584) and Aqlat Al Suqur (MP.484). Here it bends to the southwest and runs to Al Mussama.

424 - 270 Al Mussama to Medina. From Al Mussama the line continues southwest, crosses the highest point of the plateau (MP.399), and runs through Hanakiya (MP.350) to Medina.

270 - 158 Medina to Yanbu Junction. Leaving Medina, the route runs southwesterly over the summit of the Hejaz Mountains (MP.257) to the Red Sea coast. It

generally follows along wadi routes and runs through Bir Darwish (MP.241), Musajid (MP.221), Kief (MP.203), and Hamra (MP.191) to Yanbu Junction. The branch line to Yanbu is 47 miles long and runs northwesterly.

158 - 0 Yanbu Junction to Jeddah. The main line from Yanbu Junction parallels the Red Sea coast and runs southeast through Rabiqh (MP.98), and eventually turns south to Jeddah. A 43-mile long branch line eastward extends the railroad to Mecca.

The length of the main line is 854 miles and the branch lines total 124 miles, making an over-all total of 978 miles of railroad. Elevations vary from near sea level along the Red Sea coast to a maximum of 3,560 feet above sea level at the summit, highest point of the plateau, 49 miles east of Hanakiya.

4.09 CONDITIONS ALONG ROUTE

Along the entire route of the proposed railroad, field crews inspected the right-of-way and areas on both sides thoroughly for conditions that might influence the construction, operation, and maintenance of the railroad. All such information was carefully and accurately recorded.

It was found that for the major portion of the railroad, excavation will be in sand and gravel, borrow will be in like material immediately adjacent, and haul distances will be short. Some excavation will be in solid rock, particularly through the rugged Hejaz Mountains. Where the railroad crosses the Nefud between Shaqra and Usaila, drifting sand will be encountered, and this situation will require special corrective measures.

It is anticipated that all ballast will be obtained from quarries.

Suitable quarry sites were located along the entire route, and hauling distances will not be unreasonably long.

Structures will be founded either on solid rock or on firm sand and gravel. Where the foundation is sand and gravel, care is taken that the structure will not be endangered by erosion.

Water supply was found to be critical along the proposed route, and it will be necessary to drill new wells. Deep wells with motor driven pumps are anticipated.

4.10 RED SEA PORTS OF YANBU AND JEDDAH

The construction of 978 miles of railroad is a major undertaking wherever it may be located. In Saudi Arabia it will be necessary to transport much heavy equipment and materials from distant places by ship, and shore facilities must be available for the unloading. The Persian Gulf port at Dammam is excellently equipped for this purpose, but consideration must be given to the fact that it is already being used nearly to its capacity. The Red Sea port at Jedda is also fully modern, though it ranks below Dammam in equipment. This port is also being worked to near capacity. When a construction job of a magnitude such as the new railroad is being considered, it is proper to review the existing port facilities and give careful thought to how they may be made to suffice and where they may be expanded. The ports of Yanbu and Jeddah were studied with the above in mind.

Yanbu has a deep natural harbor, but no facilities for handling cargo. It was at one time the gateway for Medina, but Jeddah now has most of this traffic. The port may again become important if the harbor is improved and the railroad constructed. For traffic between the Mediterranean and the northwestern part of the Kingdom of Saudi Arabia, a modern port at Yanbu can offer a decrease in sailing distance of 200 miles and in railroad haul of 150 miles, which would be attractive both to travelers and commercial interests. The resulting relief of traffic congestion at Jeddah would be a companion benefit.

If design and construction of port improvements at Yanbu were started immediately, it would be possible to use this port during the construction of the railroad.

Jeddah has previously been referred to as the Kingdom's most important port on the Red Sea and as the gateway to both Mecca and Medina. Its modern pier was intended for truck haul only, and it is already congested with traffic. Construction of the railroad will intensify the problem unless action is taken either to divert the additional traffic or to modify and expand the existing facilities. With a view toward modifications, the design of the present pier was studied. As a result of this study, it was found that a railroad spur can be run out on the pier so that cargo can be transferred from ship directly to railroad car, provided the deck structure is strengthened and a limit is placed on the loading. Only the technical feasibility of such a modification was studied, and before a decision is reached it would be desirable to consider the entire situation of the port, including economics and projections of future traffic. It is even possible than an additional pier or enlargement of the present pier is indicated.

4.11 DESIGN OF THE RAILROAD

It is proposed that the railroad shall be of first-class quality throughout, including alignment and grades, roadbed and track, structures, all rolling stock, and the various auxilliary shops, equipment and structures for operation and maintenance. The standard gauge of 4 feet 8-1/2 inches was chosen to match existing railroad between Dammam and Riyadh.

Brief specifications and design criteria are:

Grades - Maximum grades will normally be 1.5 percent. In special cases the maximum may be increased to 2 percent, compensated for curvature.

Curves - Maximum curvature will normally be 6 degrees, except in special cases when 8 degrees may be permitted. Curves will be provided with spiral transitions and will have the outer rail super-elevated.

Ties - Ties will be of creosote-petroleum treated wood, 6 inches by 8 inches in section and 8 feet long. The spacing will be 22 ties per 39-foot rail. All ties will be fully plated.

Rails and Accessories - Rails will weigh 90 pounds per yard, and the standard length will be 39 feet. All accessories, including joint bars, track bolts, rail anchors, tie plates, track spikes, switches, and other miscellaneous items, will be of types and qualities best suited to the installation.

Ballast - Ballast will be of durable crushed stone. Minimum depth under bottom of tie will be 6 inches.

Roadbed - The top width of subgrade will be 20 feet.

Drainage - Major water courses will be crossed by steel bridges, with 40-foot long spans of wide-flange rolled steel beams, and reinforced concrete piers and abutments. Minor water courses will be provided for by single or multiple barrel culverts of reinforced concrete, with 3 feet by 3 feet square waterway openings. The required capacities have been determined by visual inspection of drainage courses.

Slope Protection - Slopes of fills and cuts will be protected by riprap wherever high velocities of water may cause erosion.

Sand Control - In areas of drifting sand, dunes will be leveled and the sand covered with a coat of oil for a distance of 200 to 300 feet on each side of the track.

Passing Tracks - Passing tracks 2,500 feet long will be spaced at approximately 25-mile intervals.

House Tracks - House tracks 700 feet long will be provided at each station. Warehouses and Special tracks will be located if and as required.

Division Points - Division points will be located at Riyadh, Anaiza, Medina and Jeddah.

Midway Stations - Midway stations will be located at Marrat, Al Mussama, and Yanbu Junction.

Line Stations - Line stations will be located at Jubaila, Dhruma, Shaqra, Usaila, Junaitha, Mudnib, Buraida, Rass, Aqlat al Suqur, Hanakiya, Bir Darwish, Musajid, Kief, Hamra, Yanbu, Rabigh, and Mecca. There is a total of 17 line stations.

Waiting Points - Shelters will be provided at numerous waiting points between line stations.

Service and Personnel Buildings - Service and personnel buildings will generally be modern structures with concrete-block walls, concrete floors, and wood roofs. They will be provided with sanitary facilities, electric light and power, and air conditioning in offices, family houses, senior staff barracks, and radio rooms of station buildings.

Buildings will be provided as follows:

At Line Stations - Station buildings; powerhouse; intermediate staff and soldier barracks; and toilet and shower buildings.

At Midway Stations - Station building; powerhouse; senior, junior, and intermediate staff barracks; soldier barracks; junior staff mess; and shower and toilet buildings.

At Division Points Anaiza and Medina - Station building; warehouse; powerhouse; senior, junior, and intermediate staff barracks; soldier barracks; senior and junior staff messes; and shower and toilet buildings.

At Division Points Riyadh and Jeddah - Station building (at Jeddah only); office building, main shop; warehouse; powerhouse; family houses; senior, junior and intermediate staff barracks; soldier barracks (at Jeddah only); senior and junior staff messes; and shower and toilet buildings.

Power Plants - A diesel engine-driven electric power plant will be installed at each station. Those at line stations will be of 100 KW capacity; those at midway stations and at Mecca will be 200 KW; and those at division points will be 600 KW. The distribution systems at all stations will be underground, using parkway type cable.

Fuel Systems - Each station will have a fuel-oil system installed, which will include unloading facilities, storage, and underground piping. In addition to this, division points will be equipped to refuel diesel locomotives.

Water Systems - A water system will be provided at each station and other places where necessary and will include pumps, storage tank, and underground piping. New wells will be drilled where that is necessary.

Communications System - A very-high frequency radio telephone system with 25 channels will provide communications for operational purposes. Twenty-four of these channels will be telephone or teleprinter channels between division points and will be available to intermediate midway stations. In addition, one radio telephone circuit will link each line station with adjacent stations, and through midway stations and division points will provide communication with any station in the system.

A separate very-high frequency radio telephone system will provide communication for traffic control purposes with locomotives and automobiles. This system will operate independently from each division point, midway station, and line station. A local telephone system, with provision for long-distance operation over the radio telephone system, will be provided at each division point and midway station.

SECTION V

EFFECT OF PROPOSED RAILROAD ON NATIONAL ECONOMY

5.01 GENERAL

The railroad had been developed technically to a point where it was an efficient and rapid means of mass transportation by about the middle of the 19th century. There then followed a long period of building, lasting until World War I, during which many financially attractive lines were constructed, mostly by private enterprise. Since then there has been an increasing trend toward government control of rate structures, and competition has developed from automobiles and trucks traveling the free public highways. This situation has caused private capital to be hesitant about investing in new lines, even if the potentialities of the investment were promising. The trend for many years has therefore been toward government ownership; and the Government of Saudi Arabia, in financing its railroad, is in step with many other countries.

For a railroad to be well conceived, it must be integrated with the economic life of the area it serves as well as the areas to which it is connected. Then the success of the railroad and the prosperity of the people develop hand in hand, the one giving impetus to the other, and the over-all benefits grow at a compounded rate. Railroads thus conceived have all been successful, while many of those that were built for a single purpose have not survived. The Saudi Government Railroad was planned in the best tradition of pioneering ventures.

In all pioneering ventures that involve the intangible human equation, it is not possible to predict accurately the degree of response from the people. The beneficial effects of the railroad cannot be evaluated quantitavely against time, but they can be predicted qualitatively. The following sub-sections will describe some of the benefits that are certain to ensue.

5.02 AGRICULTURE

In the Kingdom of Saudi Arabia there is much fertile land not now in production, but which could be cultivated profitably if water were available. The primary problem is to increase the supply of water. Most of the irrigation water now used is obtained from the upper levels of underground seepage, by means of springs, shallow wells, and trenches dug in wadis. It has been demonstrated that the water supply can be increased substantially by pumping from deep wells and by conserving the surface run-off resulting from the intense showers. This can be accomplished by drilling new wells equipped with deep-well pumps; keeping the pump motors supplied with fuel or electric power; and building dams, reservoirs, and canals. Little of this can be done without a modern system of mass transportation.

Each farming area of the world can undoubtedly contribute its share to the total knowledge on farming, and conversely each area can also draw from the experiences other areas have gained. Much scientific knowledge is available in regard to the problems of the farmer, from the preparation of the soil to the marketing of the produce. The Saudi Arabian farmer can, by judicious application of this knowledge, increase the quantity and quality of his yield, and get higher prices in the market place. Good transportation will promote the exchange of ideas and will supply the farmer with improved varieties of seeds and with fertilizer, bring him agricultural tools and machinery, and move his produce to market.

A consequence of good transportation is the tendency for farmers, individually and collectively, to specialize in certain crops. The specialization will depend on the skills and preferences of the farmer as well as on the soil, water, and climate of the area. This has long been demonstrated by the specialization in dates at Hufuf and in other parts of the country. Since sun-dried dates keep well and do not require rapid transportation or refrigeration, they have been well suited to the conditions that have existed in the area. With the advent of the railroad, it can be expected that there will be further specialization in many other crops and grains, and in perishable fruits and vegetables.

The Asir District, on the Red Sea south of Jeddah, deserves special mention although it is not on or close to the proposed railroad. Here the rainfall is the highest, and the climate and soil are favorable. It has been proposed by others that this district has a particularly high potentiality for further development in agriculture. The proposed railroad is only a partial answer to the problem of how to distribute the excess produce from Asir. Most of the exports from Asir will have to be waterborn to Jeddah, from where the railroad can carry it further.

5.03 INDUSTRY

The known oil reserves and the present oil industry are located near the coast of the Persian Gulf. These could and have been developed without a railroad across the Arabian Peninsula. Additional industries which are based on oil and produce for export can unquestionably also be successful without the railroad. However, many such industries would be more secure if they supplied a domestic market as well, and then the railroad is indispensible for transport. An immediate or early market exists throughout the country, for quantities of fuel and diesel oil to run electric power plants, which in turn will provide power for industry and homes, diesel oil and gasoline to run farm machinery, trucks, and automobiles, gasoline and kerosene for direct cooking and lighting, and bitumens for the many applications in construction. Later, with or after development in manufacturing, there will be a demand for natural gas and the products in which oil or gas are basic raw materials.

Two new industries are actively being considered at this time, the manufacture of commercial fertilizer and portland cement. Both of these will depend on oil or natural gas for power or for raw materials. Other raw materials for these industries are also to be found near the Persian Gulf. It will then be proper for the plants to be located in that area, but the railroad will be necessary to distribute that part of the product which goes into the domestic market.

Definite indications have been found of ore deposits, and in the western part of the country two mines are now producing concentrates of gold and several other metals. Geological surveying and mapping and subsurface explorations are continuing and there is good prospect of locating additional mineral deposits of commercial value. The railroad will play an important part in any new development arising therefrom.

The several small industries now existing will grow when they find wider markets through the railroad, and for the same reason new industries will develop. It is not possible to predict the course of developments accurately, but it is believed that the enterprising and industrious people will soon find that they can produce many goods more cheaply than these can be imported.

5.04 TRADE

The developments described in the preceding sub-sections on agriculture and industry will result in expanded markets and greatly accelerated trade. Much of the increased production will be traded on the domestic market, but the surplus will be exported to foreign markets, as is the case with most of the oil. Such exports alone will do the country little good; in fact, there must be a balance in the value of goods moving into and out of a country. The increased productivity and exports envisaged will result in more imports, and these in turn must be distributed.

5.05 TRANSPORTATION

The movement of goods and the railroad's indispensible part therein has been indicated. This sub-section will therefore deal with passenger traffic.

Travel is now extremely difficult through the interior. The roads between Riyadh and Jeddah are little more than trails in most places, and travel is sometimes interrupted by sand storms or flash floods. Under such circumstances, the average citizen does very little traveling. That the proposed railroad will draw a large volume of passenger traffic is demonstrated by the existing railroad between Dammam and Riyadh, where the volume of this type of business far exceeds the original estimates.

It has been mentioned earlier that Mecca and Medina are hosts to over 275,000 pilgrims each year. A small number travel by air, but essentially about half travel by ship to Jeddah and half by overland routes. It is of great credit to the faith of these people that so many of the pilgrims will endure the hardships of the present overland travel. It is certain that many more Moslems will be able to make the pilgrimage to Mecca and Medina when the railroad is in operation.

The now inoperative Hejaz Railroad between Medina and Jordan was built primarily to carry pilgrim traffic. If a way can be found to rebuild this railroad, it will again provide convenient transportation for the many pilgrims from Jordan, Syria, Lebanon and Turkey. However, with increased prosperity and production in the Kingdom of Saudi Arabia, this railroad will also carry a large volume of goods. Since this railroad is essentially a connecting link to the proposed Saudi Government Railroad, much of the traffic will also benefit the latter.

When plans are made for rebuilding the Hejaz Railroad, consideration should be given to using the standard gage of 4 feet 8-1/2 inches. This will minimize the rehandling of freight, and will permit interchange of rolling stock between the two railroads.

The Hejaz Railroad may be considered as supplementary to the Suez Canal. It could be a most important link in moving goods and passengers between Mediterranean and Red Sea ports.

5.06 STANDARD OF LIVING

The completed railroad will become a part of daily life to many people of the Kingdom of Saudi Arabia. In its wake will come more education, better health, increased water supply, new mechanical power, rapid transportation, and new vistas through travel. Through greater production and consequent prosperity, the people will acquire more amenities such as better homes, household appliances, and a more diversified and balanced diet. The standard of living will rise.

5.07 NATIONAL DEFENSE

From a military point of view, the Saudi Government Railroad, the part now existing and the proposed extension across the peninsula, occupies a strategic position and will be of paramount value to national defense. This is clearly demonstrated by the map. As compared to older means of transportation, the railroad will move an army much more rapidly from one point to any other point on the line. The railroad will also move the heaviest military equipment now in existence, and it will keep an army supplied with ammunition, fuel, food, and all other necessities for warfare. The mobility the army gets from the railroad may be considered in either of two ways, either the effectiveness of the army is greatly increased, or it is possible to get along with a smaller standing army.

SECTION VI

QUANTITY AND COST ESTIMATE

6.01 GENERAL

The technical results of the survey and designs of the Riyadh-Jeddah Section of the Saudi Government Railroad are recorded in the volume entitled "Specifications and Drawings", which is to be considered as an appendix to this report. Quantities of work required and the cost of constructing and equipping the railroad, including all necessary service facilities to make it an operating railroad, have been estimated on the basis of the specifications and drawings. The amount of rolling stock considered to be necessary is based on a preliminary study of anticipated traffic. It is intended that all materials and equipment, including rolling stock, used in construction will be purchased new and at the end of the job be turned over to the management of the railroad to be used in operation and maintenance.

6.02 QUANTITY ESTIMATE

The principal items of permanent work, material, and equipment, with estimated quantities, are:

Description	Quantity
Roadway subgrade	
Excavation, common	1,710,000 cu. yd.
Excavation, rock	743,000 cu. yd.
Embankment borrow	12,850,000 cu. yd.
Overhaul	11,443,000 sta. yd.
Roadway ballast	
Rock, quarried and processed	1,916,000 cu. yd.
Hauling and placing	1,010 track miles

Track

Ties (3,010,000 pcs.)	96,320	MBF
Rails	160,000	tons*
Other track materials	46,400	tons*
Track laying	1,010	track miles

Drainage structures

Concrete	13,000	cu. yd.
Steel reinforcement	760	tons*
Structural steel	210	tons*

Buildings

Station buildings, large	3	units
Station buildings, standard	20	units
Rural waiting stations	20	units
Office buildings	3	units
Warehouses	6	units
Main shops	2	units
Family houses	70	units
Senior staff barracks	13	units
Junior staff barracks	17	units
Intermediate barracks	57	units
Soldier barracks	25	units
Senior staff messes	4	units
Junior staff messes	7	units
Toilet buildings	57	units
Shower buildings	57	units

Miscellaneous

Power plants, large	4	units
Power plants, intermediate	4	units
Power plants, small	16	units
Water supply	36	units
Radio communications	2	systems

Rolling stock	Additional for Operation	Used in Construction
Road locomotives	1 unit	9 units
Yard locomotives	1 unit	2 units
Flat cars	0 unit	103 units
Gondola cars	21 units	36 units
Box cars	65 units	25 units
Tank cars	0 units	47 units
Refrigerator cars	6 units	4 units
Stock cars	14 units	0 unit

Cabooses	0 unit	9 units
Locomotive cranes	0 unit	2 units
Jordan spreaders	0 unit	2 units
Budd cars	7 units	0 unit
Pulman cars	12 units	0 unit
Lounge cars	6 units	0 unit
Dining cars	6 units	0 unit
Coaches, 1st class	10 units	0 unit
Coaches, 2nd class	22 units	0 unit
Baggage cars	11 units	0 unit

Notes: * 1 ton = 2,000 lb.

** It is intended that rolling stock used in construction will be purchased new.

6.03 COST ESTIMATE

The cost of the railroad in operating condition is estimated to be:

1)	Administration and engineering	$11,581,000
2)	Roadway subgrade	11,289,000
3)	Roadway ballast	11,600,000
4)	Track	57,661,000
5)	Drainage structures	7,257,000
6)	Buildings	16,263,000
7)	Power plant equipment	4,288,000
8)	Water supply	401,000
9)	Radio communications	1,521,000
10)	Rolling stock, new*	13,927,000
	Total	$135,788,000

Note: * Used units of rolling stock have been prorated to other items.

الخريطة - ١
EXH-1

المملكة العربية السعودية

سكك حديد الحكومة السعودية
خط الرياض - جدة
خريطة
البلاد السعودية

INTERNATIONAL ENGINEERING CO., INC.

DESIGNED I.E.
DRAWN S.P.L.
CHKD. P.F.S.
INSP.
SUBMITTED C.E. Buck
RECOMMENDED H.W. Birkeland
APPROVED

SAN FRANCISCO, CAL.
DATE OCTOBER, 1953
BM-10-201

الخريطة-٢
EXH-2

KINGDOM OF SAUDI ARABIA

SAUDI GOVERNMENT RAILROAD
RIYADH-JEDDAH SECTION
MAP
SAUDI ARABIA

INTERNATIONAL ENGINEERING CO., INC.

DESIGNED I.E.	CHK'D. P.F.S	SUBMITTED C.E. Buck
DRAWN S.P.L.	INSP.	RECOMMENDED H.W. Birkeland
TRACED		APPROVED T Mundaly

SAN FRANCISCO, CAL.
DATE OCTOBER, 1953

BM-10-202

الخريطة ٣
EXH-3

ملاحظة:
سيتم تعيين مواقع ٢٠ محطة انتظار قروية فيما بعد على الساحة الزراعية

NOTE:
The location of twenty rural waiting stations to be determined in field.

المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

سكك حديد الحكومة السعودية
SAUDI GOVERNMENT RAILROAD
خط الرياض - جدة
RIYADH - JEDDAH SECTION
صورة شاملة
GENERAL LAYOUT
المنشآت
STRUCTURES

INTERNATIONAL ENGINEERING CO., INC.

DESIGNED I.E.	CHKD P.F.S.	RECOMMENDED
DRAWN J.R.F.	SUBM C.E. Buck	APPROVED
OCTOBER, 1953	SAN FRANCISCO, CAL.	BM-10-203

الخريطة-٤
EXH-4

المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

سكك حديد الحكومة السعودية
SAUDI GOVERNMENT RAILROAD
خط الرياض - جدة
RIYADH - JEDDAH SECTION
صورة عامة
GENERAL LAYOUT
وصف طبيعة الأراضي
TERRAIN DESCRIPTION

INTERNATIONAL ENGINEERING CO., INC.

DESIGNED I.E.	CHKD. P.F.S.	RECOMMENDED [illegible]
DRAWN J.R.F	SUBM. C.E. Buck	APPROVED [illegible]
OCTOBER, 1953	SAN FRANCISCO, CAL.	BM-10-204

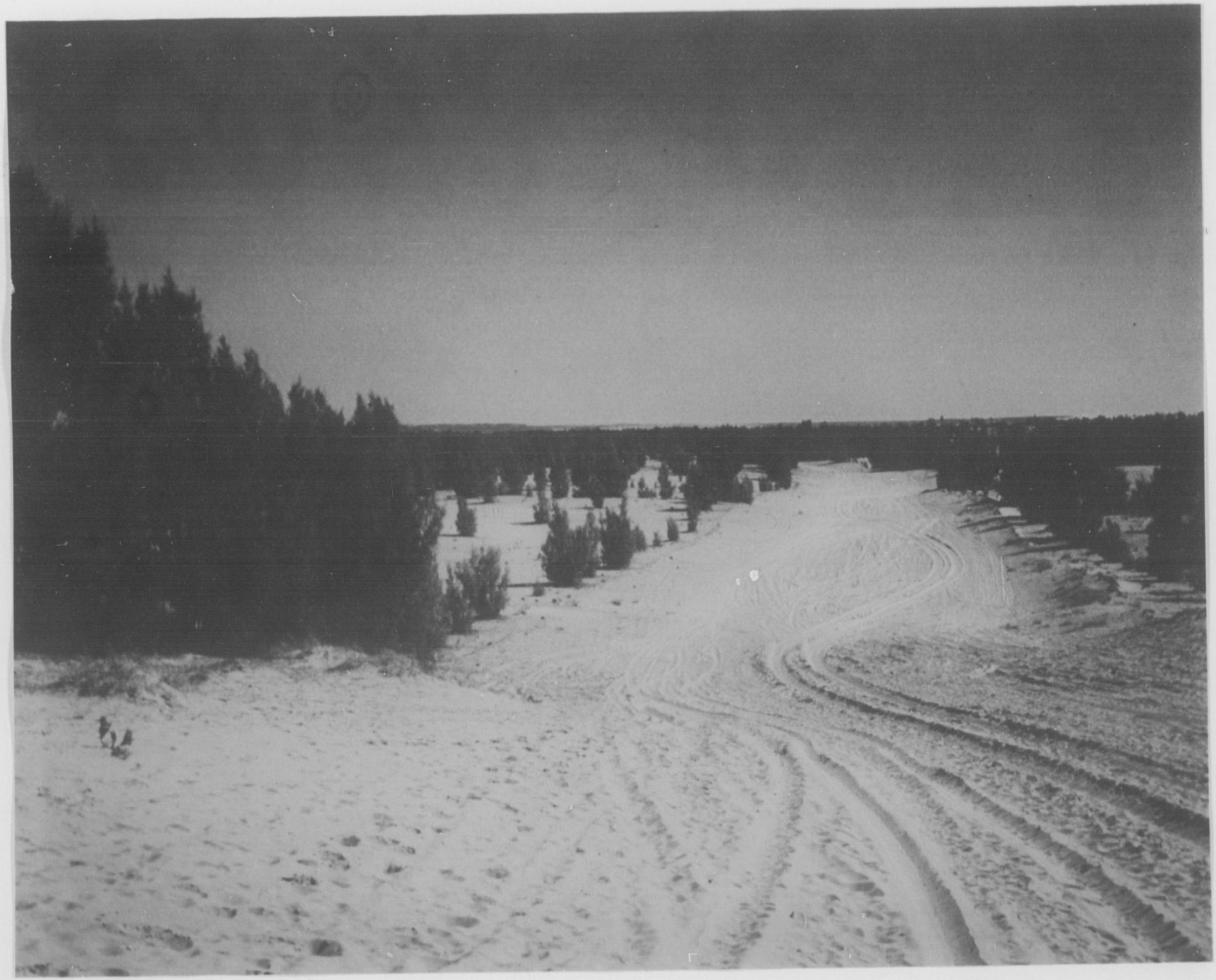


Photo No. 1 Reclaiming Sand Dunes with Tamarisk (Athel) Trees - Anaiza

الصورة رقم (١) استصلاح أراضي النفود (كثبان الرمال) بزراعة
أشجار الأثل - عنيزة

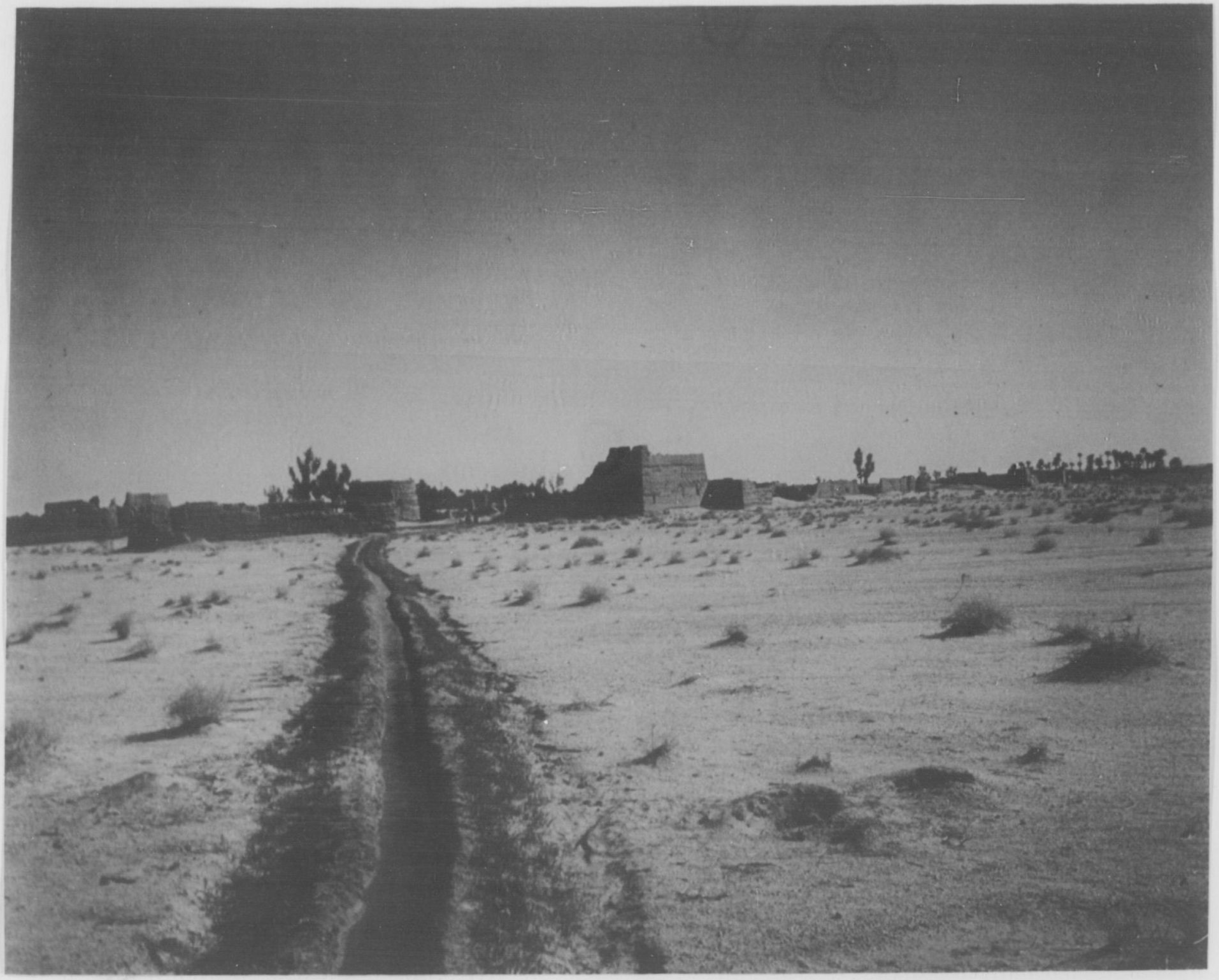


Photo No. 2 Garden and Irrigation Stream West of Anaiza

الصورة رقم (٢) حديقة وقناة ري غرب عنيزة

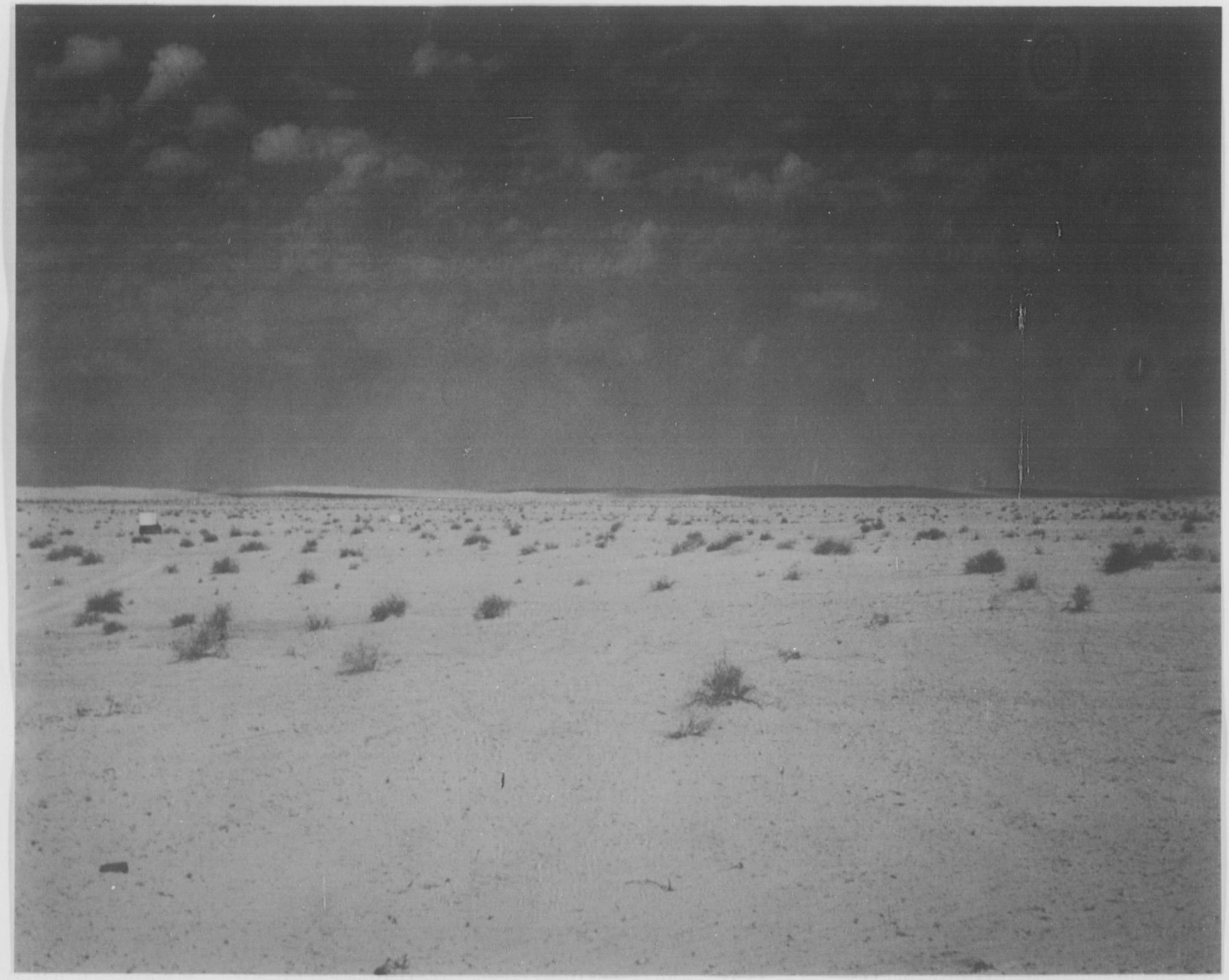


Photo No. 3 High Plains with Sand Dunes in Distance

الصورة رقم (٣) سهول مرتفعة وخلفها كثبان رمال

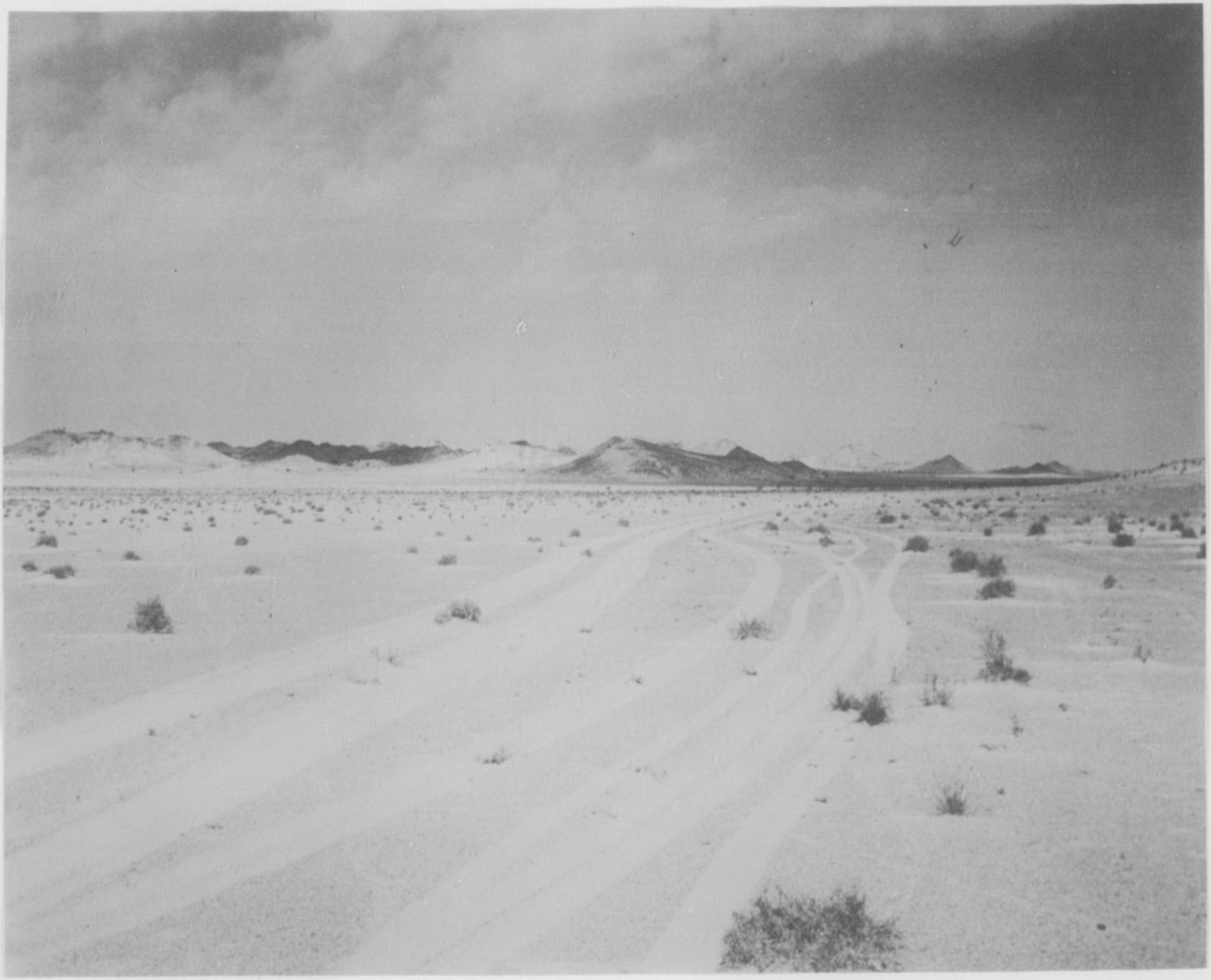


Photo No. 4 Flat Plains with Rolling Hills

الصورة رقم (٤) سهول منبسطة وبعض الهضاب المتصلة

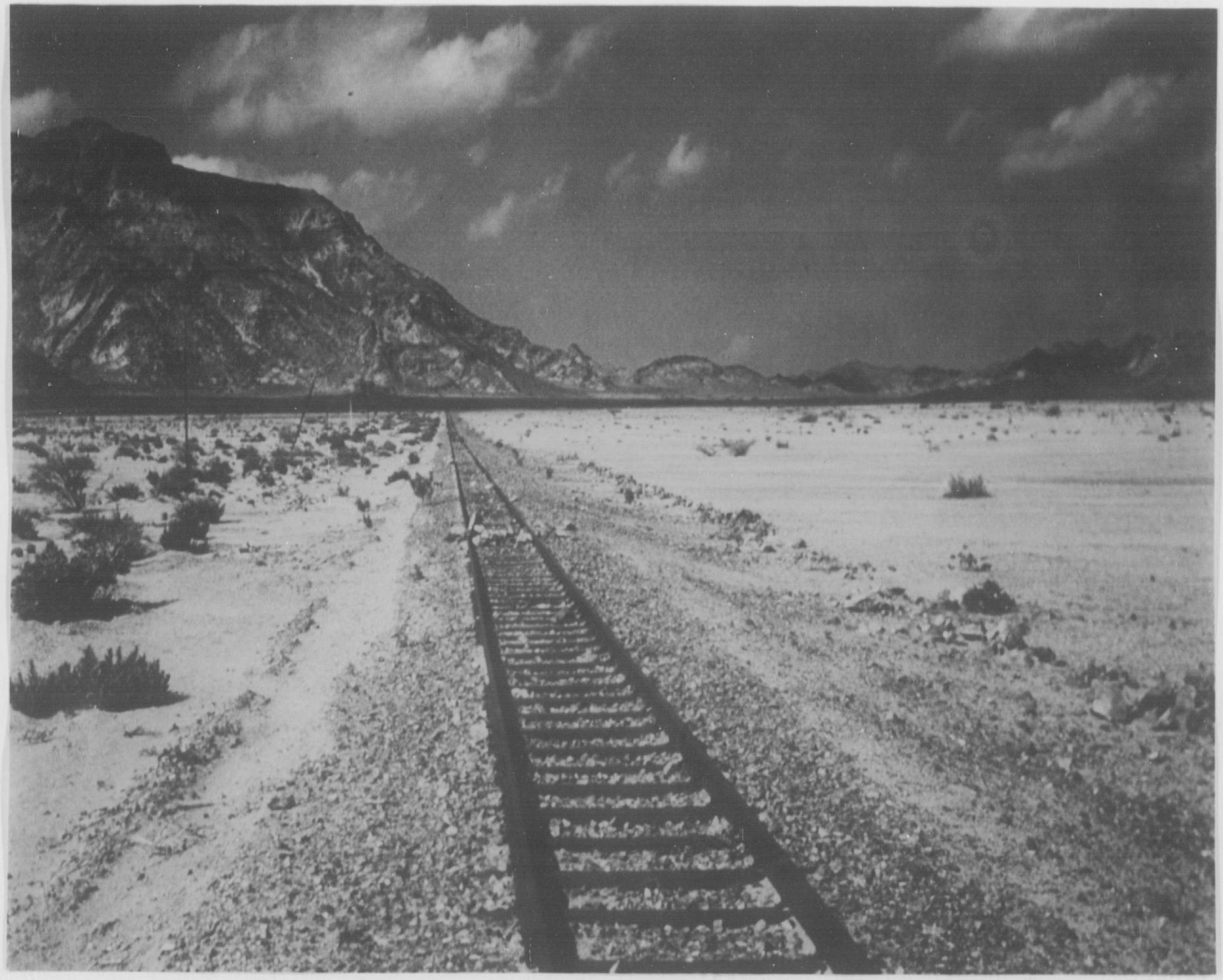


Photo No. 5 Abandoned Narrow Gauge Hejaz Railroad - Near Medina

الصورة رقم (٥) سكة حديد الحجاز المتروكة ذات الخط الضيق -
بالقرب من المدينة المنورة

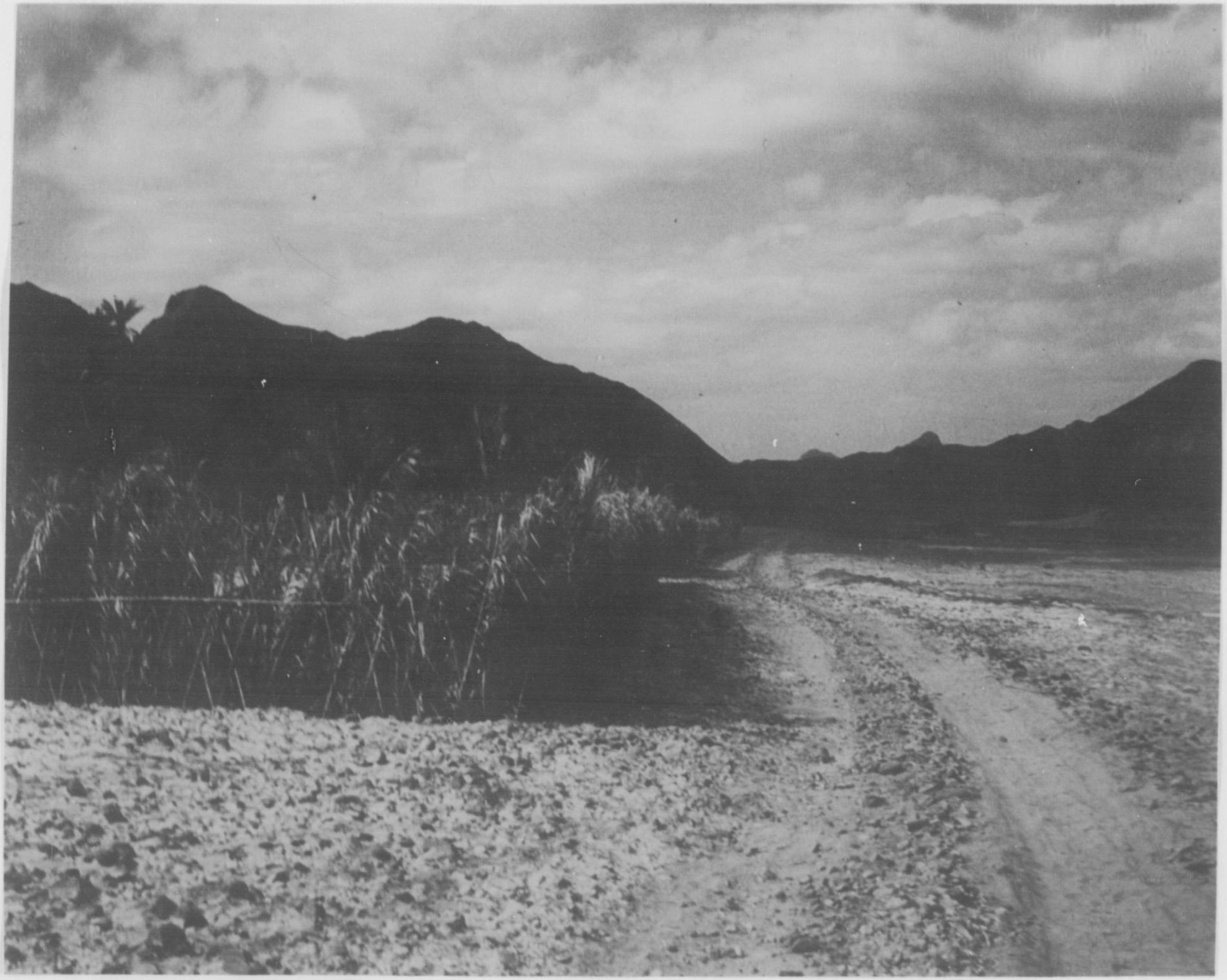
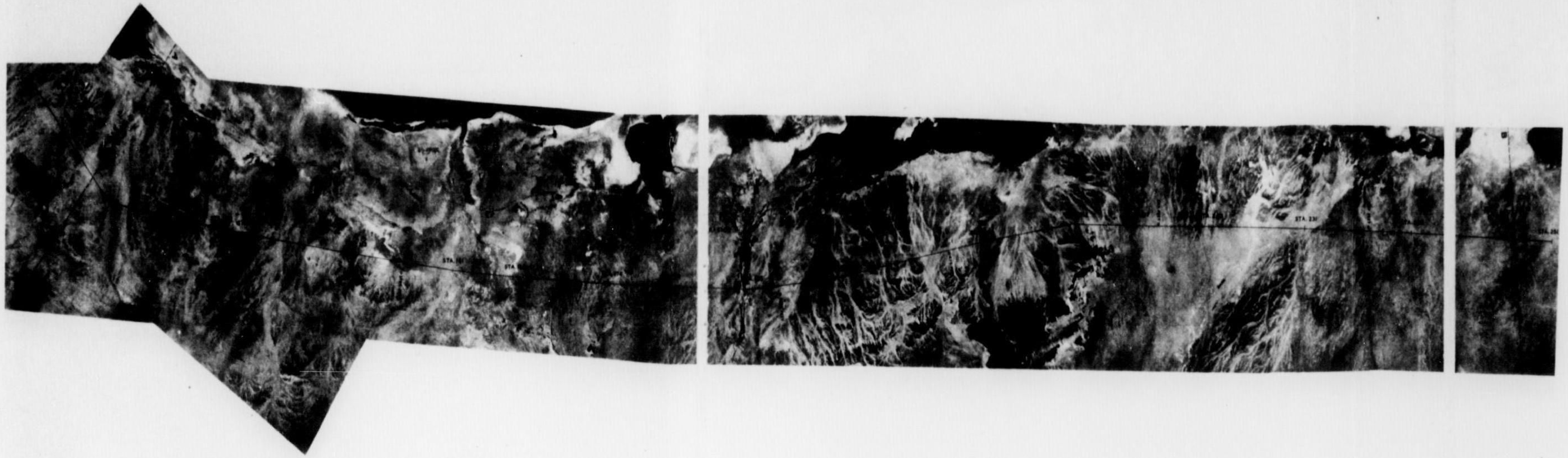
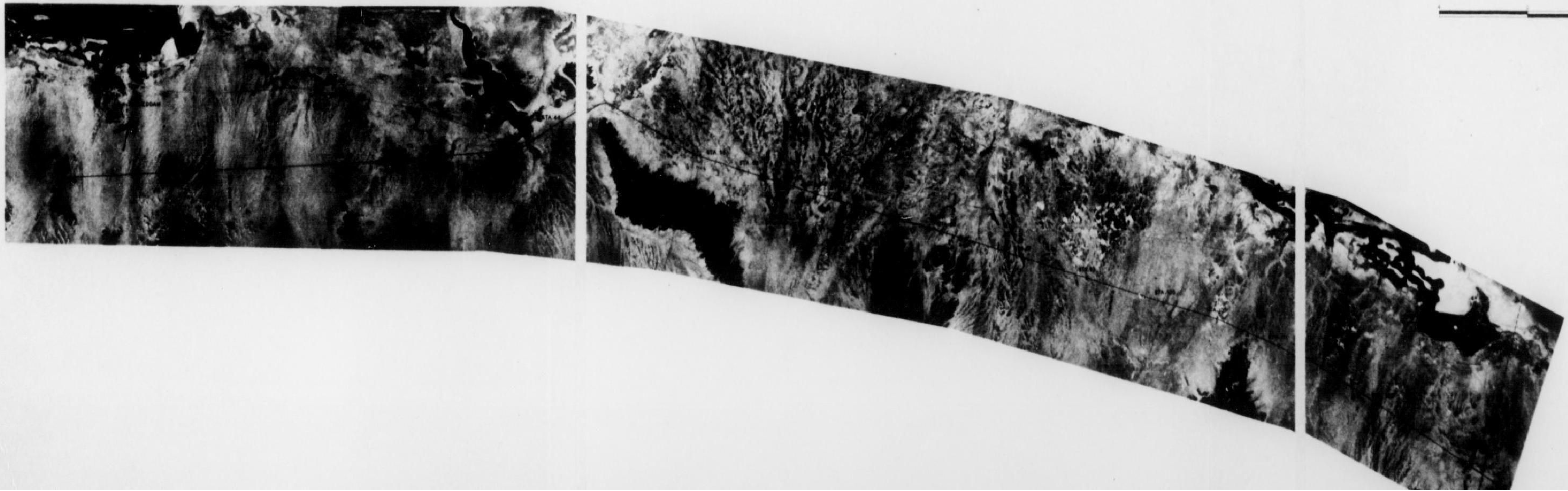


Photo No. 6 Gardens in Wadi Safra near Red Sea
Coastal Plain

الصورة رقم (٦) حدائق بوأدة صفرة بالقرب من
السهل الساحلي للبحر الأحمر





PROPOSED RAILROAD LOCATION
BETWEEN JEDDAH AND RIYADH
SAUDI, ARABIA.

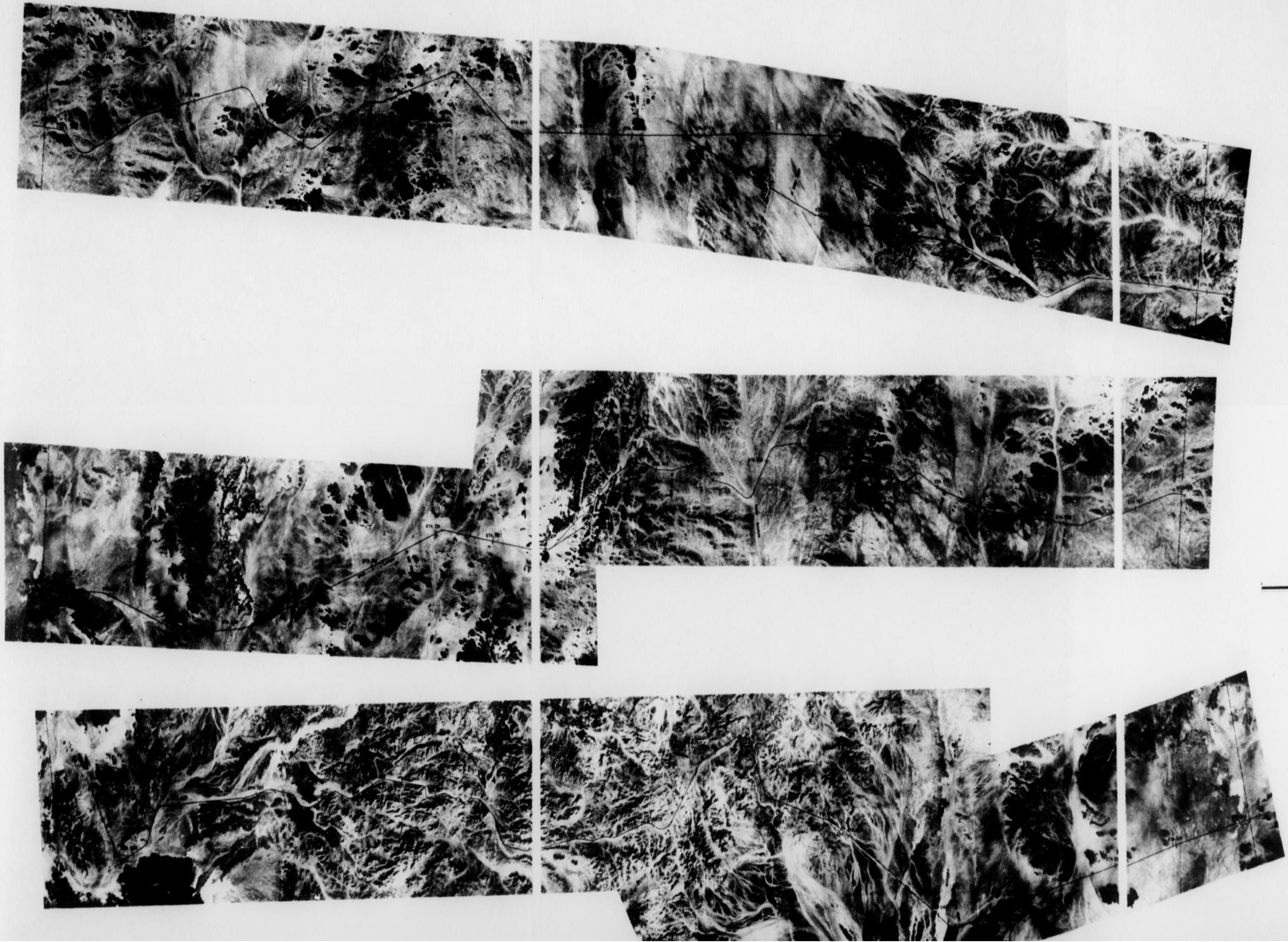
SHEET A

PROPOSED RAILROAD LOCATION

BETWEEN JEDDAH AND RIYADH

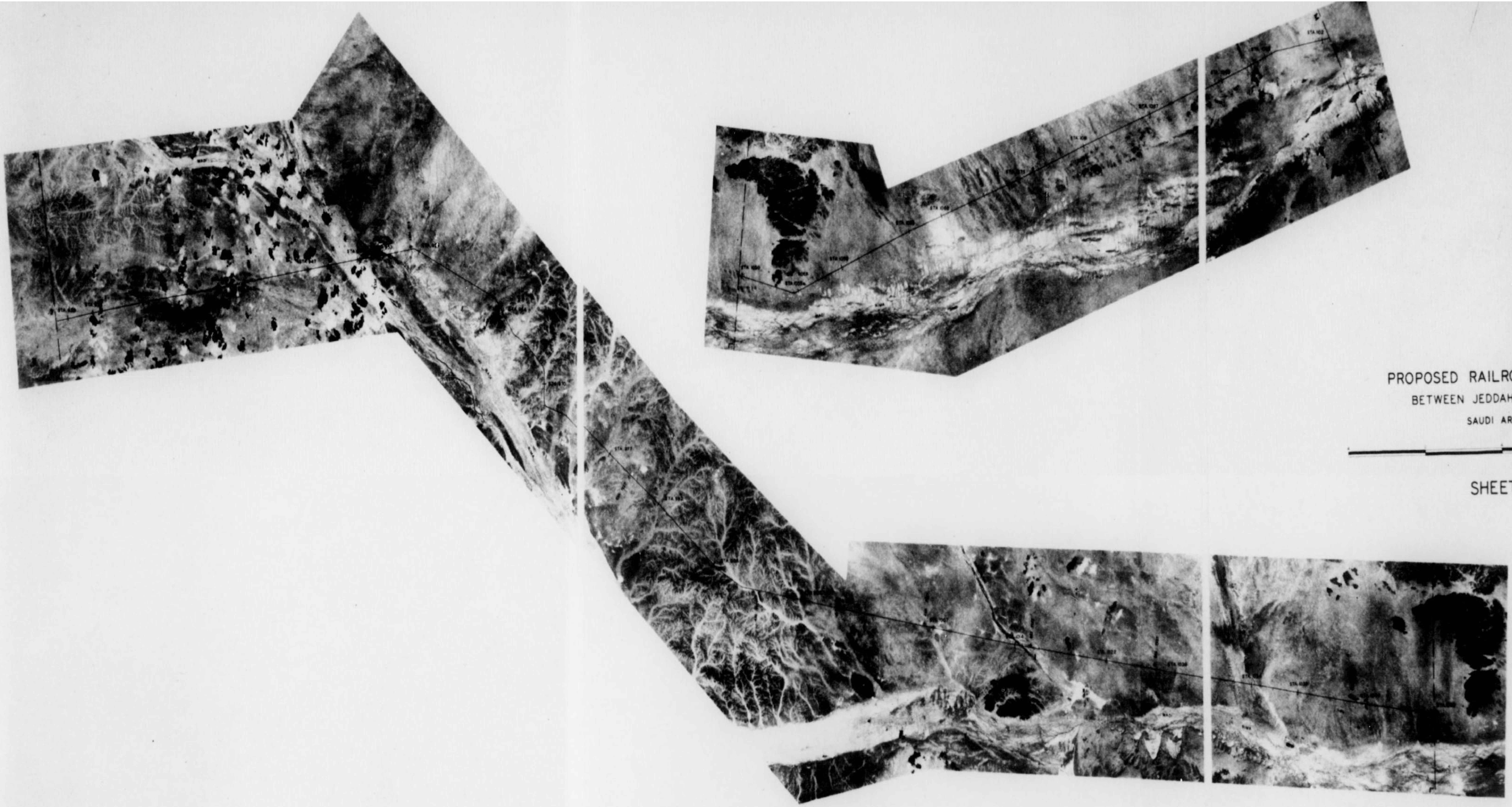
SAUDI, ARABIA.

SHEET B



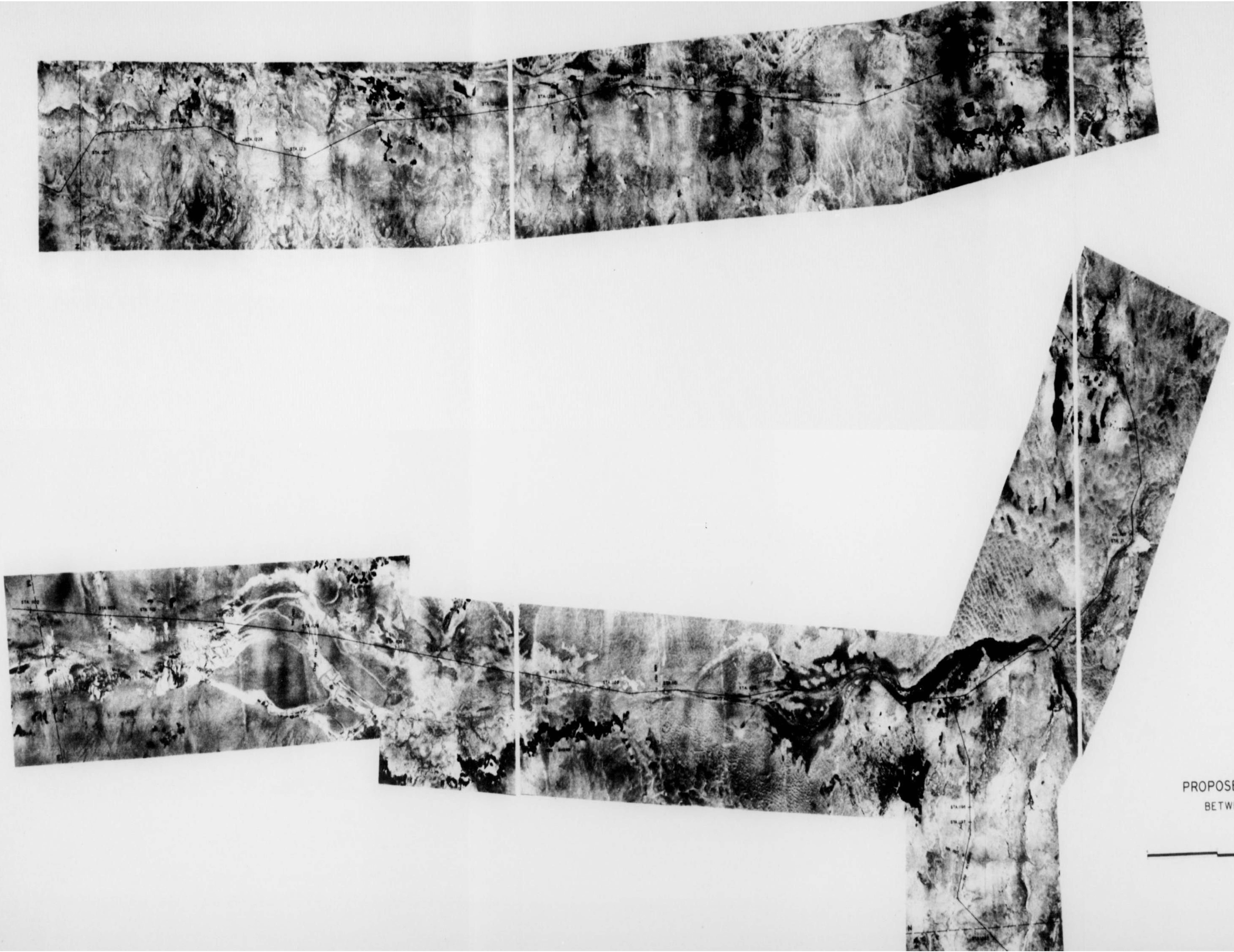
PROPOSED RAILROAD LOCATION
BETWEEN JEDDAH AND RIYADH
SAUDI ARABIA

SHEET C



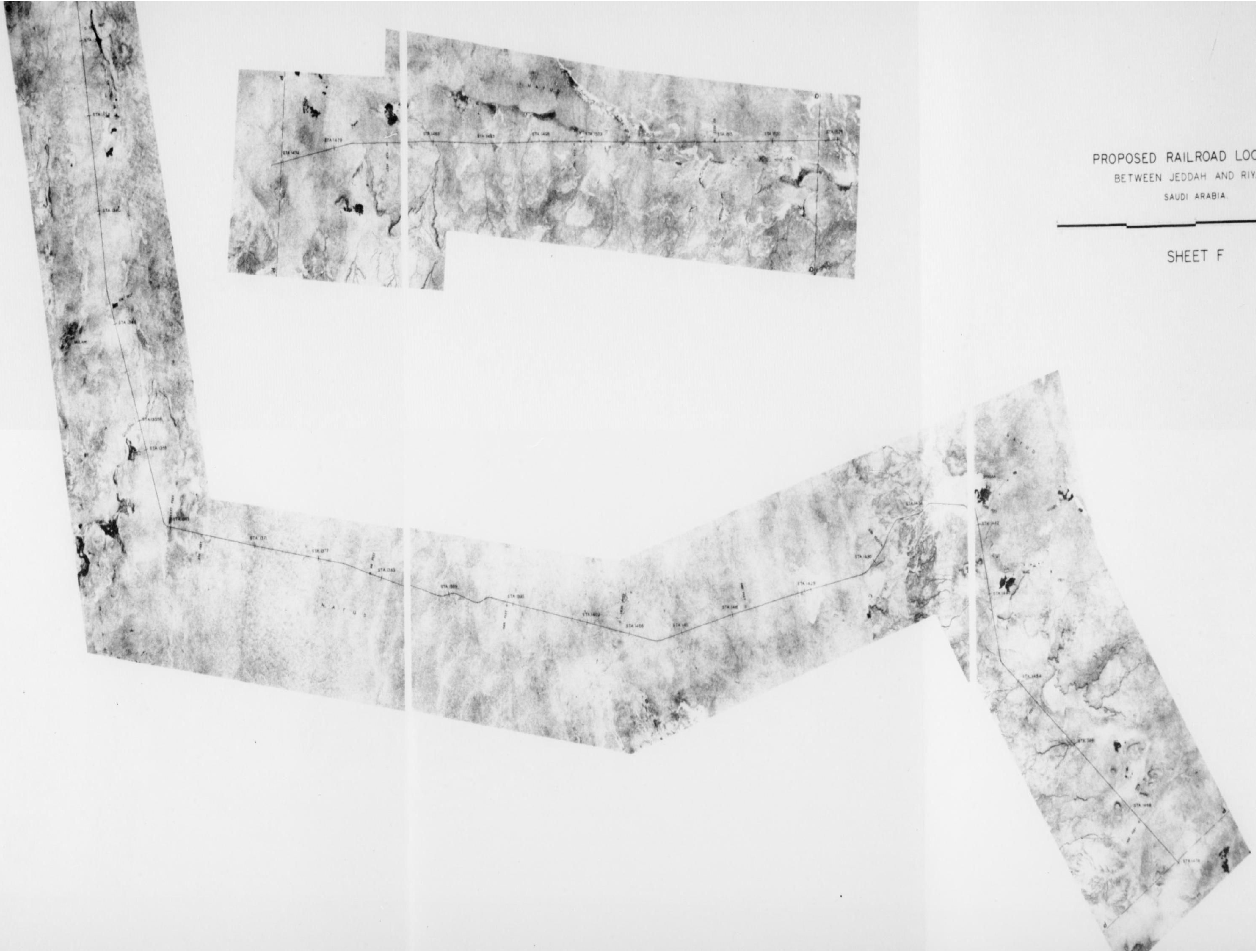
PROPOSED RAILROAD LOCATION
BETWEEN JEDDAH AND RIYADH
SAUDI ARABIA.

SHEET D



PROPOSED RAILROAD LOCATION
BETWEEN JEDDAH AND RIYADH
SAUDI ARABIA.

SHEET E

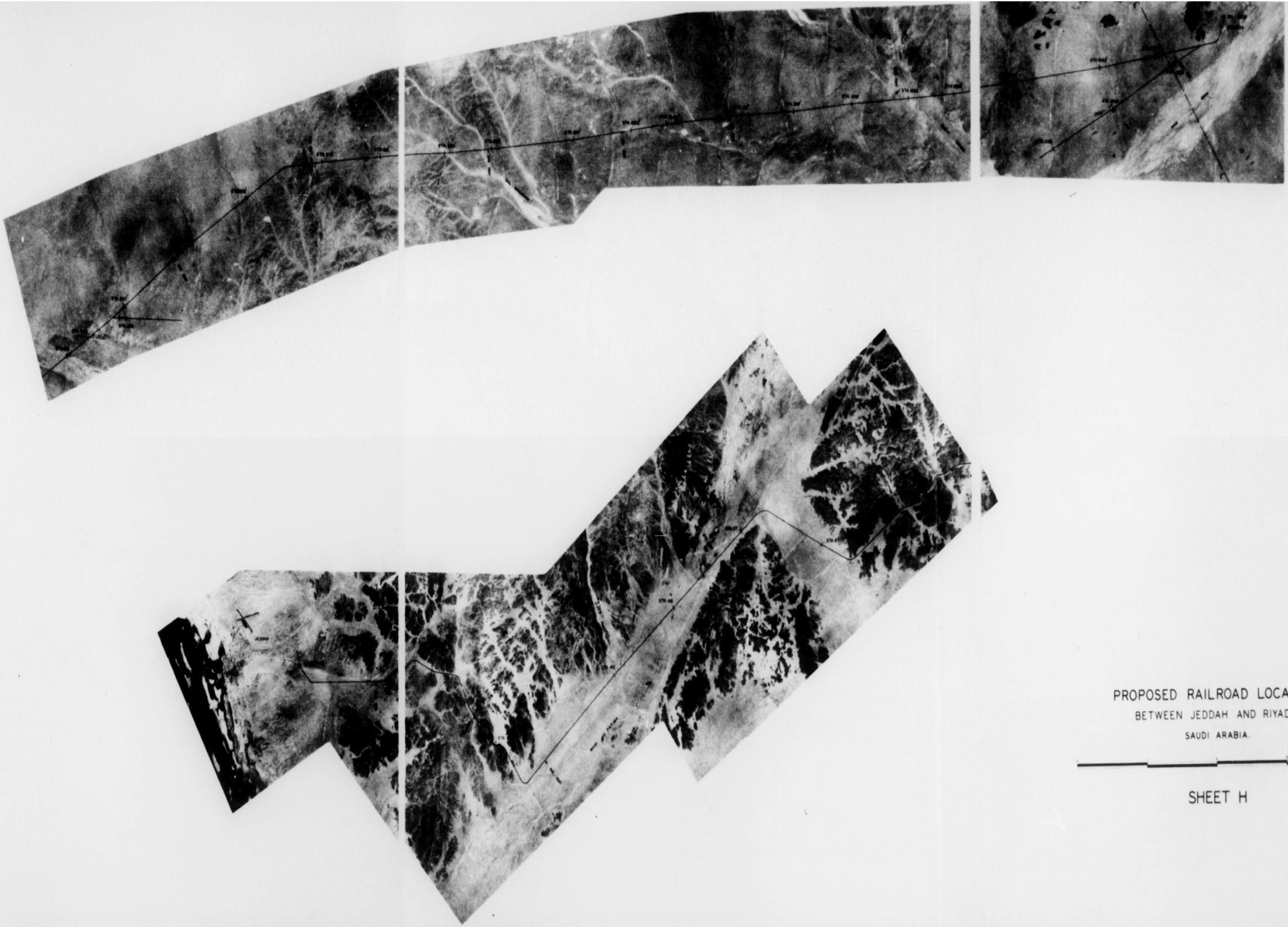


PROPOSED RAILROAD LOCATION
BETWEEN JEDDAH AND RIYADH
SAUDI ARABIA.

SHEET F

PROPOSED RAILROAD LOCATION
BETWEEN JEDDAH AND RIYADH
SAUDI ARABIA.

SHEET G



PROPOSED RAILROAD LOCATION
BETWEEN JEDDAH AND RIYADH
SAUDI ARABIA.

SHEET H